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(71) Applicants:
- **FORD MOTOR COMPANY LIMITED**
  Brentwood Essex (GB)
  Designated Contracting States:
  GB
- **FORD FRANCE S. A.**
  92506 Rueil-Malmaison Cédex (FR)
  Designated Contracting States:
  FR
- **FORD-WERKE AKTIENGESELLSCHAFT**
  50735 Köln (DE)
  Designated Contracting States:
  DE

(72) Inventor: **Richardson, Norman**
Wickford, Essex SS11 7EJ (GB)

(74) Representative: **Messulam, Alec Moses et al**
A. Messulam & Co.
24 Broadway
Leigh-on-Sea Essex SS9 1BN (GB)

(54) A heat exchanger

(57) A heat exchanger includes a side support (4) which has a thermal stress relieving zone (12) in the form of a gap (12) which completely separates one end of the support (4) from the other. The gap (12) is generally symmetrical about a central axis parallel to the longitudinal axes of the tubes (6) of the heat exchanger and is shaped such that a straight line cannot be drawn through the gap from one side of the side support (4) to the other side. The symmetrical gap (12) reduces asymmetric stress patterns without leaving any fin (8) unsupported.

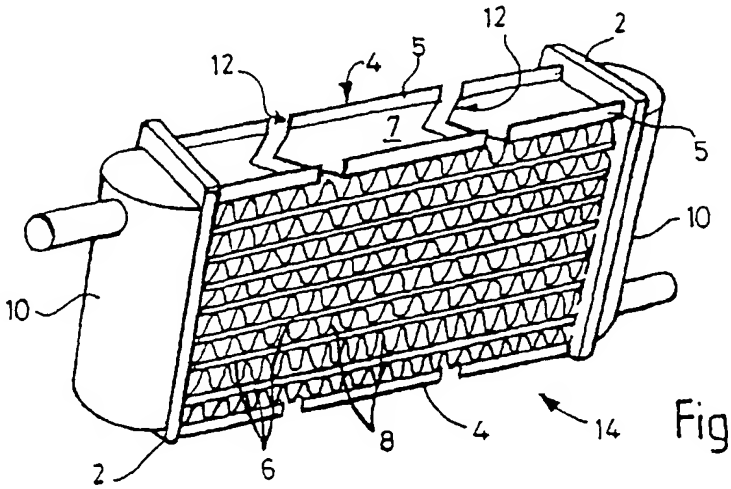

Fig. 3

EP 0 748 995 A2

Description

The present invention relates to a heat exchanger which has thermal stress relieving zones. The invention is for use particularly, though not exclusively, in a radiator for a motor vehicle.

Typical vehicle heat exchangers, such as car radiators, include a plurality of thin walled tubes disposed between a pair of headers. The ends of the tubes are rigidly connected to the headers, and fluid can pass from one header to the other via the tubes. The tubes are interleaved with corrugated fins, and the tubes and fins are supported by a pair of side supports which extend between the headers and are rigidly secured thereto. The component parts of the heat exchanger are first assembled and then connected together by brazing or welding according to the materials from which each component is constructed.

A function of each side support is to limit deformation of the tubes close to the edge of the heat exchanger occurring as a result of internal pressure in the heat exchanger. The fins between the side support and the tube nearest to the side support are important for the transfer of loads between the tubes and the side support.

It is important to provide means for relieving thermally induced stress in the side support. This stress arises when coolant heats up the tubes, causing them to expand more rapidly than the side supports. If the side supports and the tubes are made from different materials, having different coefficients of thermal expansion, the stress build-up would be exacerbated. Longitudinal stress induced by this differential expansion can result in premature failure of the heat exchanger.

In a known design of heat exchanger, a thermal stress relieving zone comprises a linear saw cut made across each side support, which severs the side support completely through.

A problem with saw cutting is that it is very noisy, difficult to automate, and produces a lot of metal fines resulting in increased downtime and maintenance of the saw.

It is known to make a cut using a lancing technique, which requires the use of a side support which has a generally planar base portion and a pair of flanges extending generally perpendicularly to the plane of the base. A linear slot is formed in the base by a stamping operation prior to securing the side support between the headers and to the fins. After the side support has been secured to the headers and the fins, the flanges are then sheared by a lancing technique at points adjacent the slot. The lancing completely fractures the flanges, forming the thermal stress-relieving zone as a gap which completely separates one end of the side support from the other end.

The lancing technique requires a relatively wide slot in order to provide an adequate target for the lance cutter. This technique reduces the problems associated with saw cutting, but with the resulting wide gap the fin support necessary to transfer loads between the side support and the tube is locally lost, resulting in reduced fatigue life under repetitive pressure cycling.

It has been proposed in US 5 165 153 and US 5 257 454 to make a heat exchanger which includes a side support as described above, which has a gap disposed at an angle with respect to a plane perpendicular to the longitudinal axes of the tubes. The above documents, which are incorporated herein by reference, also disclose apparatus and a method for making the heat exchanger.

Such angular gaps in the side supports allow each adjacent fin to be supported by the side support on at least a part of its surface. However they have a drawback of producing asymmetric stress patterns which we have found to result in torsional moments on the side support, which can reduce the lifetime of the heat exchanger. Moreover the manufacturing process is made more complicated because it is necessary to ensure that each radiator is correctly orientated during the cutting stage so that the parts of the flanges adjacent the slot are correctly positioned by the cutters.

It is an object of the present invention to reduce at least one of the above mentioned problems.

According to a first aspect of the present invention there is therefore provided a heat exchanger having the characterising features set forth in Claim 1.

The invention provides a heat exchanger in which each fin is supported by the side support, and in which asymmetric stress patterns are substantially reduced.

Because the gap is symmetrical, the cutting step in manufacturing the radiator is not sensitive to the orientation of the radiator when the gap is located in the middle of the side support.

The heat exchanger may be mounted in a frame to enable it to be attached to adjacent heat exchangers in order to form a large cooling assembly. The present invention relates particularly to a radiator for a motor vehicle, and will be illustrated with reference to such a radiator. However it is to be understood that the invention is not limited to this embodiment.

The invention also provides a method of manufacturing a heat exchanger having a thermal stress relieving zone therein as set forth in the characterising portion of Claim 5.

The shearing of the flanges is preferably carried out by means of a lance cutting operation.

Preferably the slot is V-shaped or chevron-shaped, although the invention is not limited to the use of these shapes.

A novel side support suitable for use in manufacturing a heat exchanger according to the invention may be manufactured and sold separately. Accordingly, a further aspect of the invention provides a side support having the features set forth in the characterising portion of Claim 7.

The invention will now be further described by way of example, with reference to the figures of the following

drawing in which:

Figure 1 is a perspective view of a vehicle radiator;

Figure 2 is an exploded side elevation view of a vehicle radiator;

Figure 3 is a perspective view of a vehicle radiator in accordance with one aspect of the present invention;

Figure 4 is a perspective view of a side support which is provided with a known thermal stress relieving zone;

Figure 5 is a perspective view of a side support of the radiator shown in Figure 1;

Figure 6 shows perspective views of side supports in alternative designs of known radiators;

Figure 7 is a perspective view of a novel side support of the radiator shown in Figure 3; and

Figure 8 is a perspective view of part of the side support shown in Figure 7, prior to lance cutting.

Similar parts and features have been similarly labelled in all the drawings.

The assembled radiator 14 shown in Figure 1 comprises a pair of headers 2 connected to fluid tanks 10. A plurality of thin walled tubes 6 are rigidly connected at each end between the headers 2 so that coolant fluid may flow from one header to the other *via* the tubes 6.

A pair of side supports 4 are disposed between the headers 2 and rigidly connected thereto, the headers 2 and side supports 4 forming a rigid frame. Each side support 4 comprises a generally planar portion 7 and a pair of flanges 5 which are generally perpendicular to the plane of the base portion 7.

A plurality of corrugated fins 8 are disposed between each of the pipes 6, and between the pipes 6 and the side support 4, as best seen in Figure 2 which shows a similar, though not identical, radiator 14.

Each side support 4 is provided with two gaps 12, made by lance cutting, as best shown in Figure 5. Prior to assembly of the radiator 14 the side support 4 was formed with a linear slot which extended right across the base 7 between the junctions of the base 7 with the flanges 4. Subsequent to assembly and brazing of the radiator 14, both flanges 5 were sheared by a lance cutter so as to form the gap 12.

The gaps 12 relieve thermal stress between the pipes 6 and the side support 4. However one or more of the fins 8 is not supported by or in contact with the side support 4 as shown in Figure 5. Load transfer between the side support 4 and the nearest pipes is therefore lost, and the radiator 14 has a reduced fatigue life under repetitive pressure cycling.

The alternative known side support 4, shown in Figure 4 has a thin gap 12 made by a saw. Because the gap is thinner than the width of contact between the side support 4 and a corrugation of the corrugated fins 8, each fin 8 is supported by the side support 4. However making the gap 12 by means of a saw produces a lot of noise and generates a lot of metal fines which is undesirable.

The embodiments shown in Figure 6 illustrate a known attempt to overcome the problems outlined with reference to Figures 4 and 5. Here, the side support 4 has been provided with a gap 12 by a lance cutting technique as described above. The relatively wide gap 12 is at an angle to an axis parallel with the tubes 6 and consequently the side support 4 supports all adjacent fins 8 along at least some of their surface.

However, both the gap 12 produced by asymmetric lancing shown in Figure 6a, and the gap 12 produced by symmetric lancing in Figure 6b result in undesirable asymmetric stress distributions when the radiator is in operation. We have found that such asymmetric stress patterns cause torsional moments which may reduce the lifetime of the radiator. Also the lance cutting operation must be performed with the radiator 14 in the correct orientation if the cuts are to be made in the correct locations in the flanges 5.

In the radiator shown in Figure 3, the side support 4 is provided with a generally V-shaped, or chevron-shaped, gap 12 which is symmetrical about a central axis parallel with the longitudinal axes of the tubes 6. The gap 12 is such that a straight line cannot be drawn through the gap 12 from one side of the side support 4 to the other side.

The gap 12 was formed from a side support 4 having a chevron-shaped slot 9 in its base 7 by shearing the flanges 5 in a lance cutting operation similar to that described above. Part of the side support 4 prior to the lance cutting operation is shown in Figure 8. The slot 9 may be manufactured in situ, but is preferably preformed, for example by a cutting or stamping process.

Each fin 8 still receives local support from the base portion 7 of the side support 4 over at least a part of its surface, but additionally there is no, or very little, resulting asymmetric stress induced by the gap configuration, and consequently little or no torsional moment is induced in the side support.

Symmetrical gaps 12 such as shown in Figure 7 may be made during the cutting operation regardless of the orientation of the radiator core. This allows easier and simpler manufacture of the radiator.

The chevron shaped gap shown in Figure 7 illustrates one possible shape of gap in a radiator in accordance with the invention. However the invention is not limited to this embodiment. It is to be understood that many alternative non-linear shapes are also possible, for example U-shaped or arcuate gaps, provided that a straight line cannot be drawn through the gap from one

side of the side support to the other and has a central symmetry axis which is generally parallel with the longitudinal axes of the tubes.

Claims

1. A heat exchanger having a thermal stress relieving zone (12) therein, the heat exchanger comprising a pair of headers (2), a pair of side supports (4), a plurality of elongate tubes (6), and a plurality of fins (8), the side supports (4) being rigidly connected to both headers (2), and each tube (6) being disposed between the side supports (4) and rigidly connected at each end to both of the headers (2) so as to define a plurality of air paths therebetween, the fins (8) being disposed in the air paths, at least one of the side supports (4) having a thermal stress relieving zone comprising a gap (12) which is generally symmetrical about a central axis generally parallel to the longitudinal axes of the tubes (6) and which gap (12) completely separates one end of the side support (4) from the other end, characterised in that the shape of the gap (12) is such that a straight line cannot be drawn through the gap from one side of the side support (4) to the other.

2. A heat exchanger as claimed in Claim 1, wherein the gap (12) is generally v-shaped or chevron shaped.

3. A method of manufacturing a heat exchanger having a thermal stress relieving zone (12) therein, the method comprising the steps of:

   forming a heat exchanger comprising a pair of headers (2), a pair of side supports (4), a plurality of elongate tubes (6) and a plurality of fins (8), the side supports (4) being rigidly connected to both headers (2), and each tube (6) being disposed between the side supports (4) and rigidly connected at each end to both of the headers (2) so as to define a plurality of air paths therebetween, the fins (8) being disposed in the air paths;

   wherein at least one of the side supports comprises a generally planar base portion (7) and a pair of flanges (5) extending generally perpendicular to the plane of the base portion (7), the base portion (7) being provided with a slot (9) which extends from one flange (5) to the other and which slot (9) is generally symmetrical about a central axis generally parallel to the longitudinal axes of the tubes (6); and

   forming a thermal stress relieving zone (12) by a shearing operation on at least one of the side supports (4) which carries the slot (9), so as to fracture both flanges (5) adjacent the slot (9) and completely separate one end of the side support (4) from the other;

   characterised in that the shape of the slot (9) is such that a straight line cannot be drawn through the slot (9) from one flange (5) to the other.

4. A method as claimed in Claim 3, wherein the shearing of the flanges (5) is carried out by means of a lance cutting operation.

5. A method as claimed in Claim 3 or Claim 4, wherein the slot (9) is generally v-shaped or chevron shaped.

6. A heat exchanger obtainable by the method of any one of Claims 3 to 5.

7. A side support (4) suitable for use in the manufacture of a heat exchanger as claimed in Claim 1, the side support (4) having a generally planar base portion (7) which has a pair of ends for connection to a pair of headers (2), a pair of sides, and a pair of flanges (5) extending along the sides generally perpendicular to the plane of the base portion (7), the base portion (7) being provided with a slot (9) which extends from one flange (5) to the other and which is generally symmetrical about a central axis generally parallel to the flanges (5), characterised in that the shape of the slot (9) is such that a straight line cannot be drawn through the slot (9) from one flange (5) to the other.

8. A motor vehicle which includes a heat exchanger as claimed in any one of claims 1, 2, or 6.

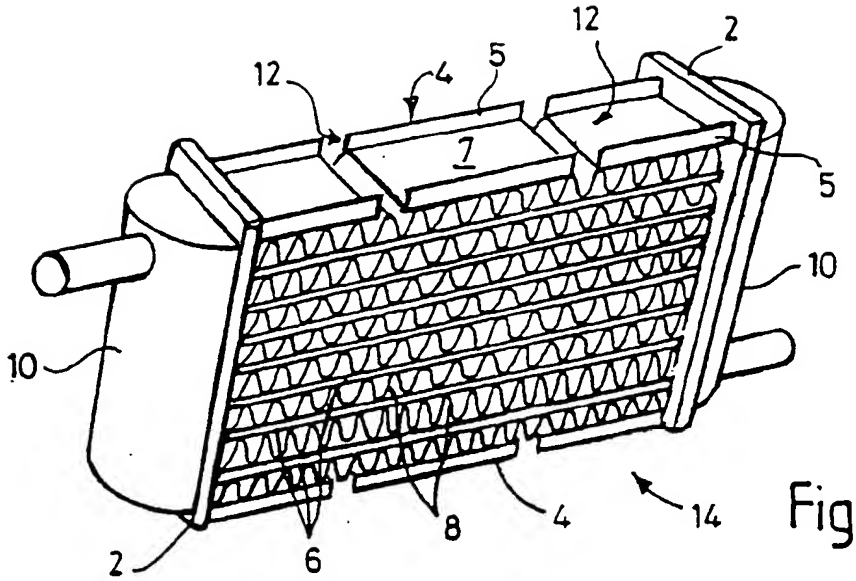

Fig. 1

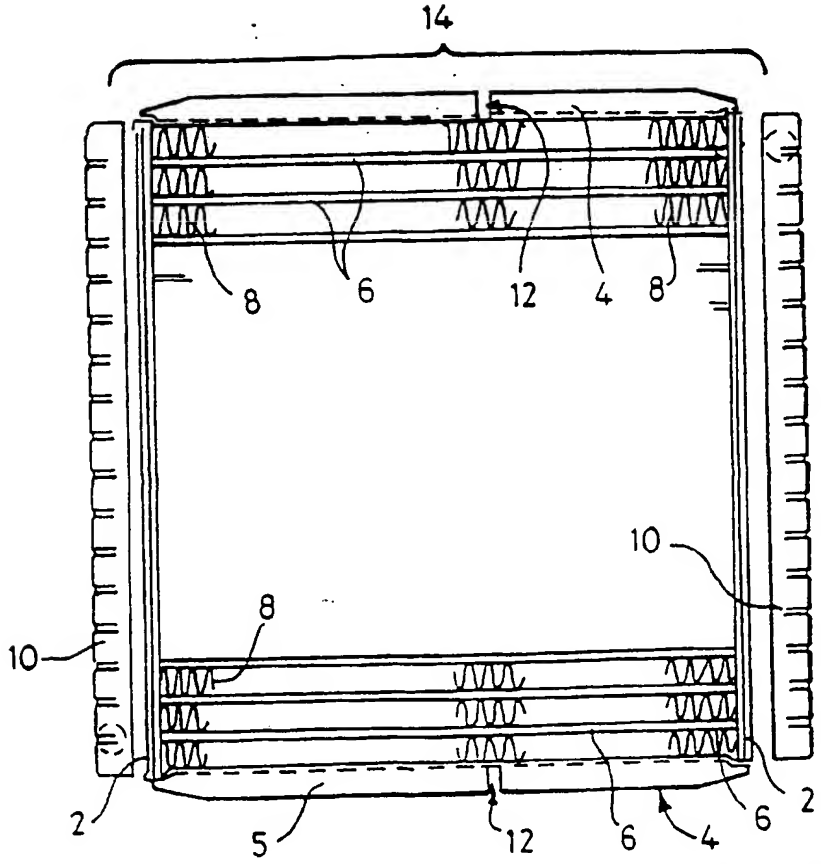

Fig. 2

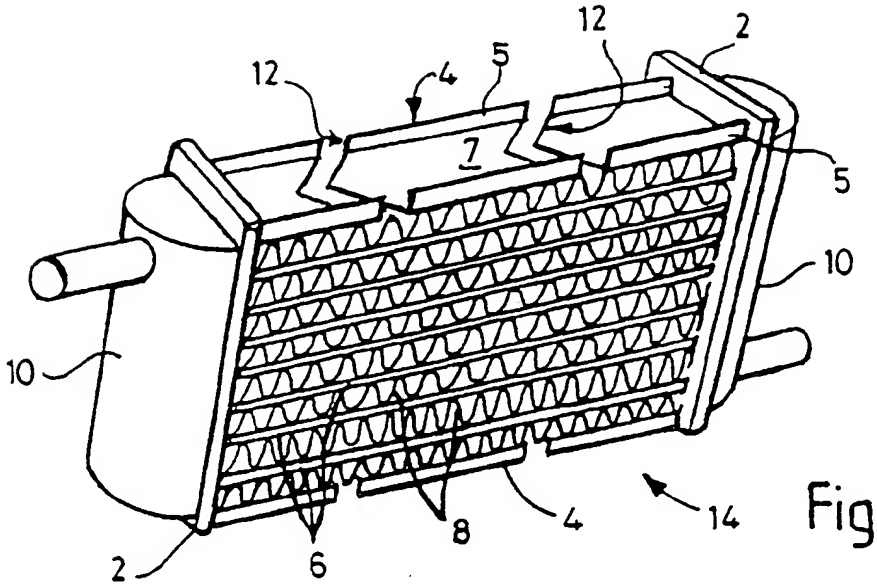

Fig. 3

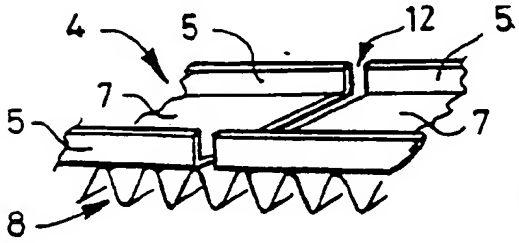

Fig. 4

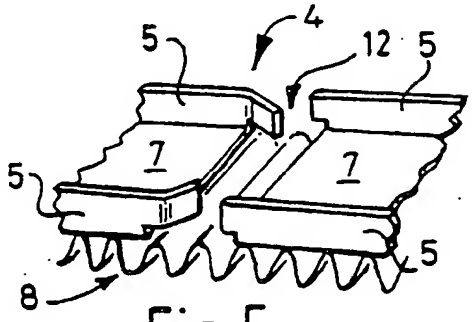

Fig. 5

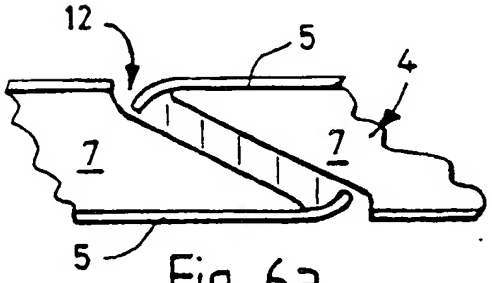

Fig. 6a

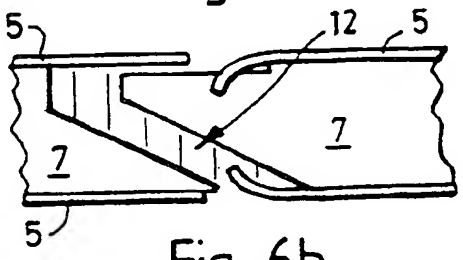

Fig. 6b

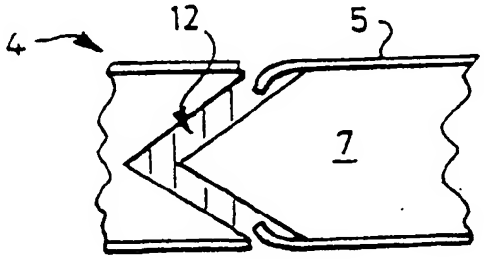

Fig. 7

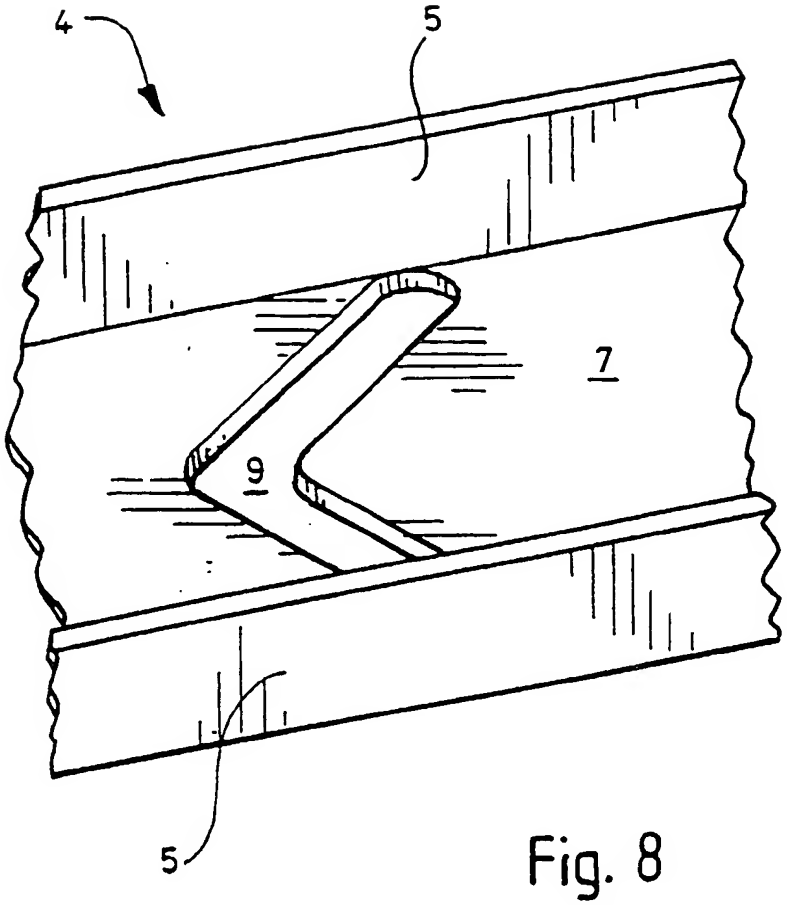

Fig. 8

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  50735 Köln (DE)
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(72) Inventor: **Richardson, Norman**
Wickford, Essex SS11 7EJ (GB)

(74) Representative: **Messulam, Alec Moses et al**
A. Messulam & Co.
24 Broadway
Leigh-on-Sea Essex SS9 1BN (GB)

(54) A heat exchanger

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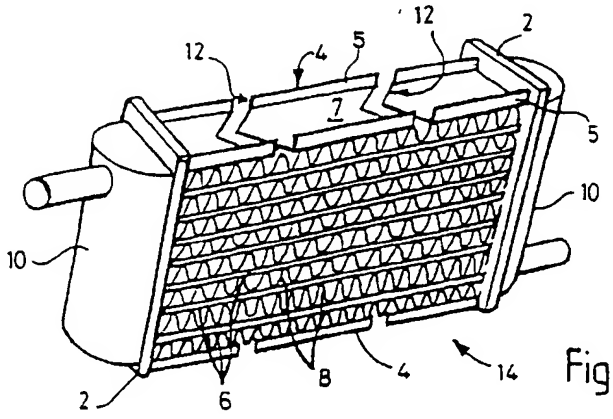

Fig. 3

EP 0 748 995 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 30 4278

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	US 4 719 967 A (SCARSELLETTA) * column 2, line 35 - column 3, line 44; figures 2-7 *	1,3	F28F9/00
A	FR 2 224 727 A (S.A. DES USINES CHAUSSON) * page 5, line 33 - page 6, line 2; figure 8 *	1,3	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

F28F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	19 February 1997	Beltzung, F

CATEGORY OF CITED DOCUMENTS

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